

Consumer Uses of Industrial Minerals in the San Francisco Bay Area—Houses to Interstates

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Few people realize the importance of industrial minerals in their everyday lives. The average American uses about one million pounds of industrial minerals during a lifetime. The term “industrial minerals” includes nonmetallic minerals such as limestone, clays, cement (portland and masonry), dimension stone, and aggregates. Although aggregate is not a mineralogical definition, it is a commercial designation for a group of mineral products that include industrial sand and gravel, construction sand and gravel, and crushed stone.

California—Value of Nonfuel Mineral Production

In 1997 California was the third leading state in the Nation in total nonfuel mineral production value. The term “nonfuel mineral production” and related “values” encompass variations in meaning, depending on the minerals or mineral products. Production may be measured by mine shipments, mineral commodity sales, or marketable production (including consumption by producers) as applicable to the individual mineral commodity, (U.S. Geological Survey, 1997, p. 53). The estimated value for 1998 was \$2.97 billion, with industrial minerals accounting for more than 90 percent of the total value (fig. 8.1).

California was the only state in 1998 to produce boron, rare-earth concentrates, and asbestos. Approximately 60 percent of the boron produced is used in the manufacture of glass, glass fibers, and insulation. The largest use of rare earth metals is in the manufacture of catalysts for chemical processes. Rare earths are also used as a glass additive, as phosphors in laser crystals, and in nickel-hydrate rechargeable batteries. In 1999, Americans used more than 15,000 tons of asbestos. Asbestos is used in roofing products, gaskets (which are resistant to heat and corrosion), and friction products such as in automotive brakes and clutches (Virta, 2001).

The state remained first in 1998 in the production of diatomite, portland cement, and construction sand and gravel. Diatomite is used as an absorbent for industrial spills, as pet litter, a filler in paints, insulation, mild abrasive, or as an additive in cement and other compounds. Cement is produced from a silty limestone consisting of calcite, clay minerals, and a small amount of iron oxide. Cement can be used alone but is used more commonly as a component of concrete, which is a mixture of cement, sand, gravel, and/or other industrial minerals. The most common type of cement, which hardens when water is added, is portland (or hydraulic) cement. For additional information on aggregates see Goonan (1999) and Tepordei (1997).

California continued to be second in the production of feldspar and magnesium compounds. Feldspar is used in glass and ceramics and is added to aluminum for improving hardness and durability. Magnesium compounds are used in aluminum alloys and as structural components of automobiles and machinery. California was one of only two states that reported production in 1998 for soda ash, titanium, and mercury. Soda ash is essential as a raw material in glass and detergents and in other important industrial applications, such as paper manufacturing and water treatment. Titanium is used in high-temperature applications, such as combustion engines and parts of aircraft and spacecraft. Thirty percent of the weight of a modern aircraft may consist of titanium. Mercury is used for the manufacture of industrial chemicals and for electrical applications. California was the first of two states to produce natural sodium sulfate, used in soaps, detergents, pulp and paper, and textiles.

California was also a leading producer of clays, gypsum, talc, masonry cement, industrial sand and gravel, and salt. Clays are used in sanitary ware, ceramic tiles, as an absorbent, as a sand-bonding agent added to portland cement, as a refractory product (heat-resistant bricks and blocks), and in the paper industry. Gypsum is one of the most widely used minerals in the world. It is estimated that the typical new American home contains more than 7 metric tonnes of gypsum. Talc is used in the paint, paper, and plastics industries. Salt is added to food as a flavor enhancer, used in the paper, pulp and textile, and water purification industries, and used to make many consumer-related end-use products such as neoprene rubber and polyvinyl chloride (PVC).

Industrial minerals are produced at several dozen sites in the San Francisco Bay area. Figure 8.2 shows those locations active in seven Bay area counties in 1997-1998.

A Typical House—Construction and Manufacturing Minerals

Construction and manufacturing minerals are the least recognized of the world's minerals. An average house contains 60 tons of concrete products, 7 tons of gypsum (wallboard), 5 tons of sand, gravel, and stone, and 0.1 ton of glass (Kesler, 1994). A wide variety of industrial minerals are used to build a typical house (fig. 8.3).

- Roof and attic: asphaltic roof shingles or rolled roofing, imitation red clay tile, roof sealant around vent flanges, insulation.
- Ceiling and walls: gypsum wall board, joint cement, paper joint tape, caulking compounds, paint, adhesive for pipes, decorative tile, fireplaces made of brick or stone.
- Floor and foundation: portland cement concrete slab, clays for floor tile, a sand foundation for pipes, adhesive for floor tile, and grout for ceramic tile, clay or PVC pipes.
- Appliances: porcelain kitchen sink, particle board for kitchen cabinets, ceramic tiles, adhesive and caulking, glass shelves, insulation.
- **Clays**, of various types, are used in bricks, concrete, books, cosmetics, and dishware/ceramics.
- **Limestone** is used in concrete, books, carpets/rugs, and cosmetics.
- **Industrial sands** are used in computers, telephones (a telephone contains items made from over 40 different types of minerals), cameras, televisions, drinking glasses, windows, and microwaves. Quartz, which comes from industrial sands and gravels, is the basic constituent of glass. Glass is analogous to steel and cement in that it consists largely of a processed mineral raw material (industrial sand) with mineral additives.
- **Construction sand and gravel** are used to make our driveways (concrete pavement) and the roads we drive on. The average six-room house requires 39 tons of aggregates
- **Salt** is used not only for cooking but also in detergents and in the manufacturing of plastics and rubber products.

For a list of construction minerals used in a house see the Nevada Commission on Mineral Resources, Division of Minerals Web site on construction materials used for a kitchen (http://minerals.state.nv.us/prog_education/construct.htm) and Weathers and others (2000).

Aggregates—Buildings to Highways

Aggregates are composed of rock fragments that may be used in their natural state or after mechanical processing such as crushing, washing, or sizing. Natural aggregates include sand, gravel, and crushed stone. Recycled aggregates consist mainly of crushed concrete and crushed asphalt pavement (Goonan, 1999). Construction aggregates are used for road base, riprap, cement concrete, plaster, and asphalt. As American society grows, the demand for new infrastructures such as industrial buildings and highways grows. Natural aggregate is very inexpensive, but it cannot be transported more than a few miles from its source without becoming prohibitively expensive; transportation more than six miles from the aggregate source adds \$1 per ton in transportation cost (Kesler, 1994). Mining of aggregates near urban centers can increase atmospheric pollution (particulate matter—dust) and create other environmental problems related to groundwater resources. The price of aggregates constitutes as much as half of the cost of cement in some cities in the northeastern United States. In many areas of the United States conveniently located aggregate reserves are becoming scarce. As our infrastructures, especially roads, need replacement or become obsolete, they are demolished, creating large quantities of demolition waste that yields 200 million metric tons of recycled aggregates annually. Asphalt paving material is recovered from demolished roads and is recycled as aggregate for road base or as asphalt binder. It is estimated that more than 100 million tons of concrete and worn-out asphalt pavement are recycled annually into usable aggregates. “Aggregates produced from recycled concrete supply roughly 5 percent of the total aggregate market (more than 2 billion tons per year), the rest being supplied by aggregates from natural sources such as crushed stone, sand, and gravel” (Goonan, 1999). The bulk of the aggregates recycled from concrete are used as road base, the remainder for new concrete mixes, riprap, and general fill. Figure 8.4 shows the materials flow cycle for aggregates. The future of the aggregate industry will be determined by the availability of raw material (natural or recycled aggregates), demand for new infrastructure, and favorable transportation distances.

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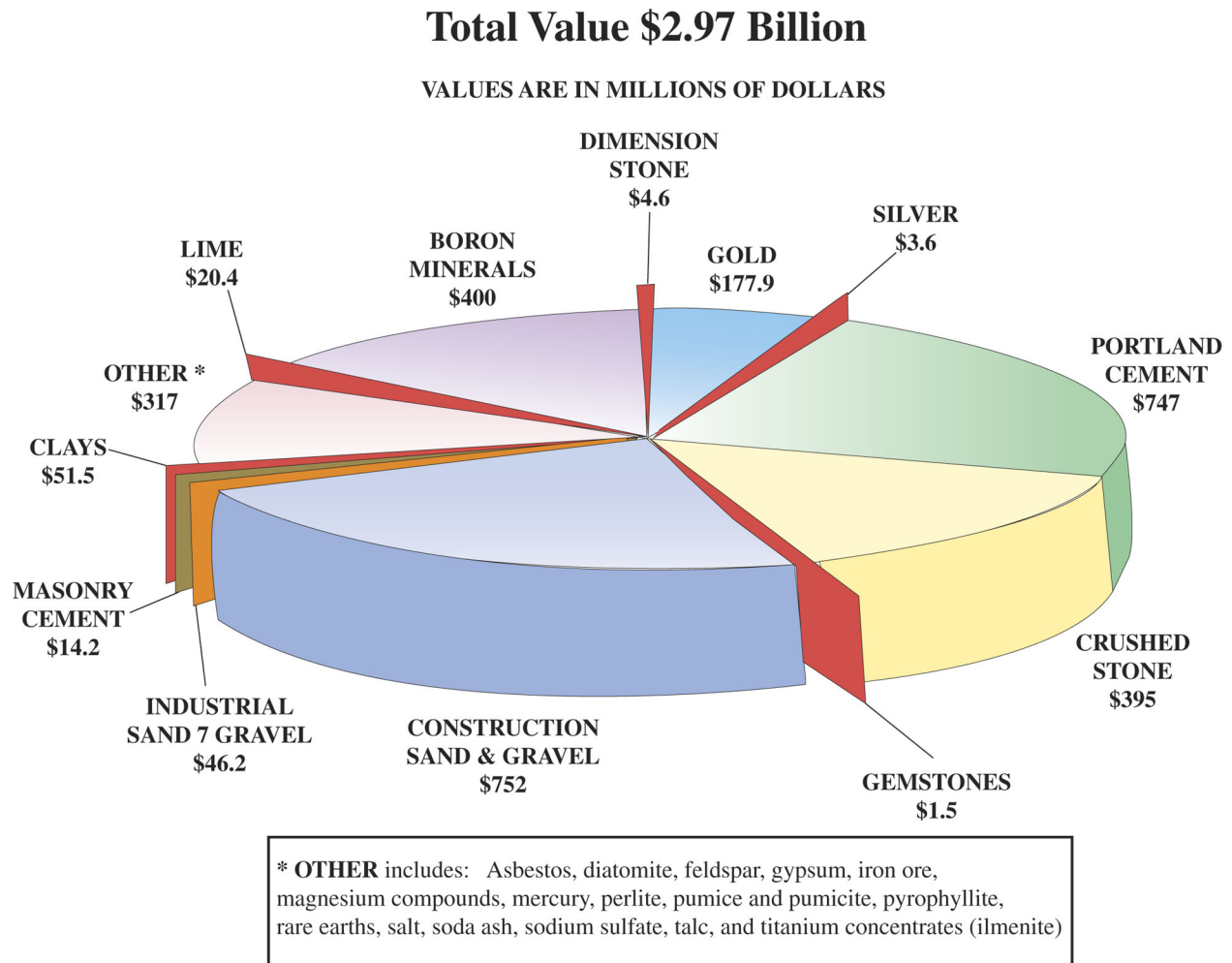


Figure 8.1. Value of production of California non-fuel minerals, 1998 (modified from Larose and others, 1999, fig. 2).

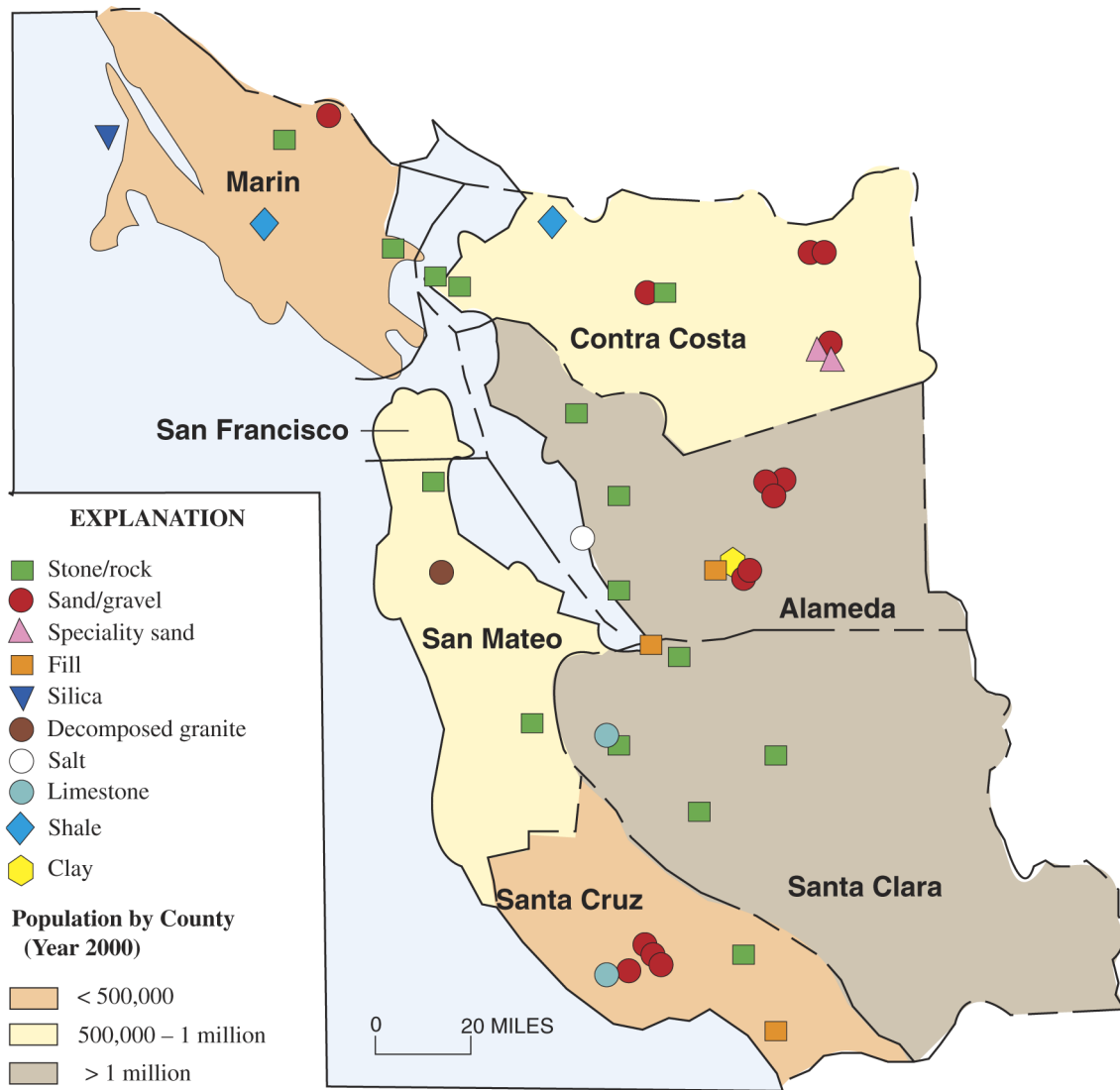
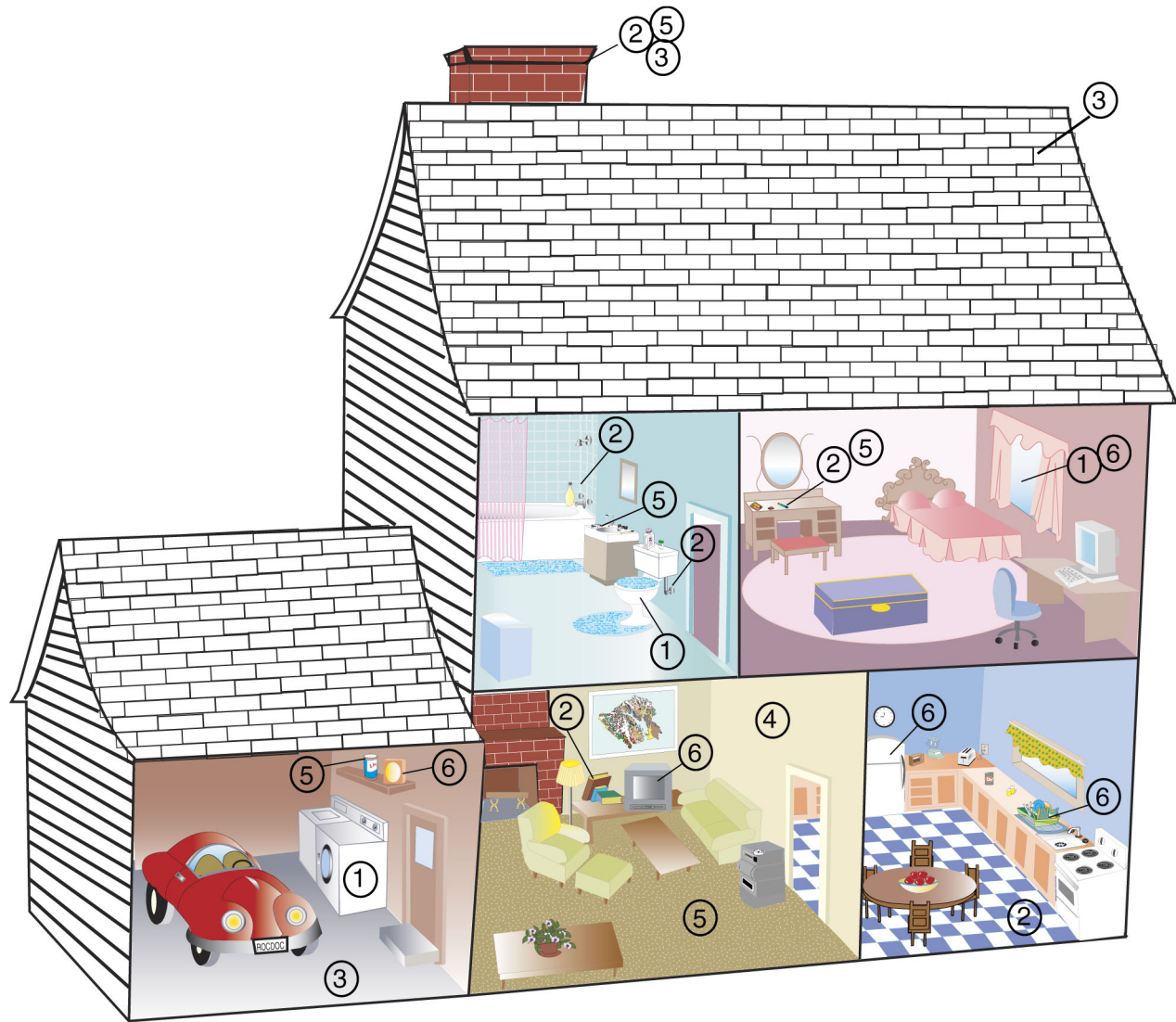


Figure 8.2. The mines and (or) mineral resource producers active in seven Bay area counties (1997-1998) and the commodities they produced (modified from Larose and others, 1999, fig. 2).



- ① BORON minerals - windows, toilet, appliances, insulation
- ② CLAYS - bricks, added to concrete, books/paper, cosmetics, plumbing, ceramics, floor tiles, dandruff shampoo.
- ③ CONSTRUCTION SAND/GRAVEL - combined with concrete, asphalt or plaster, crushed stone (decorative), sand bedding for sewer pipes, bricks
- ④ GYPSUM - plaster, wallboard, added to cement
- ⑤ LIMESTONE/CALCITE - portland cement, toothpaste, abrasive cleanser, books/paper, carpet, cosmetics
- ⑥ INDUSTRIAL SAND/GRAVEL - basic constituent of glass - windows, television, refrigerator shelves, fiberglass, dishware, mild abrasive

Figure 8.3. Some industrial mineral uses in a typical house.

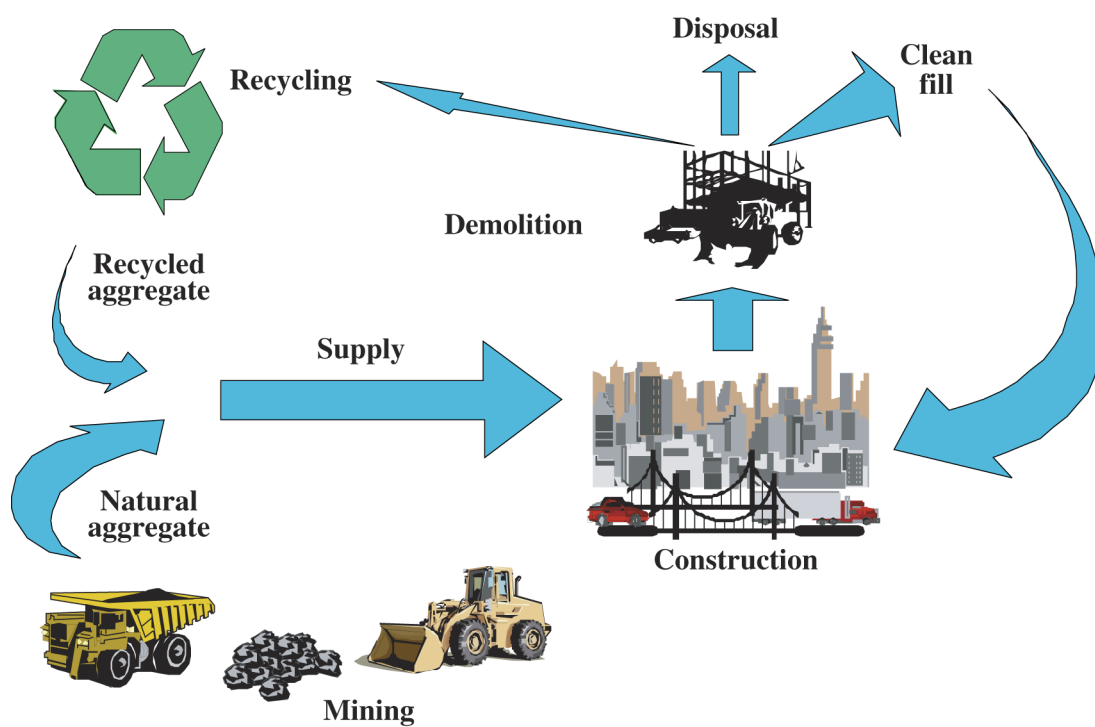


Figure 8.4. Material flow cycle for aggregates (from Sznopek and Brown, 1998).

